

NASA SBIR/STTR Technologies

A3.02-9894 - Unstructured, High-Order Scheme Module with Low Dissipation Flux Difference Splitting for Noise Prediction

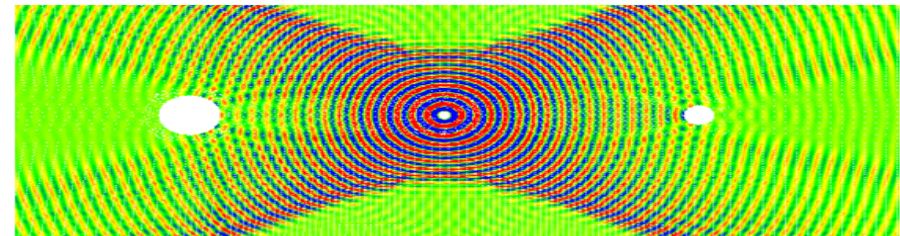


PI: H Yang

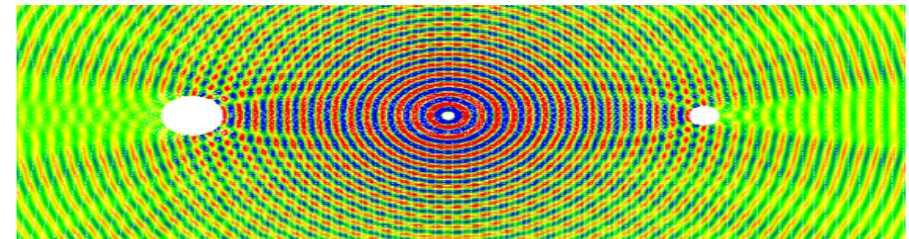
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Identification and Significance of Innovation

Despite significant progress made in computational fluid dynamics (CFD) in past several decades, some production unstructured CFD codes used at NASA for noise prediction are only 2nd order accurate at best. In this SBIR study, we propose to develop a modular high-order scheme with low dissipation flux difference splitting that can be integrated into existing CFD codes for use in improving the solution accuracy and to enable better prediction of complex physics and noise mechanisms and propagation. The salient features of our proposed approach include: (1) high-resolution schemes with physics-based low-dissipation flux-difference splitting; (2) very low memory requirements; and (3) modular structure for easy integration into existing CFD codes.



2nd Order Scheme



3rd Order Scheme

Estimated TRL at beginning and end of contract: (Begin: 3 End: 6)

Technical Objectives and Work Plan

The overall objective of this project is to develop an innovative plug-and-play high-order scheme module with low-dissipation flux difference splitting, to enable high-order accurate solution from existing unstructured production CFD codes used at NASA for aeroacoustic predictions and analysis. The Phase I objective is to develop the plug-and-play high-order module and demonstrate the feasibility of achieving high-order accuracy by integrating with a NASA CFD code, FUN3D. The work plan is:

1. Develop a generic 3rd order interpolation module for density-based, unstructured CFD code;
2. Integrate the module into NASA unstructured CFD code, FUN3D, and evaluate the accuracy with respect to the designed accuracy for a 2-D acoustic wave propagation problem;
3. Modify the Roe's flux-difference splitting scheme to reduce numerical dissipation and evaluate the improvement of the modified Roe's Riemann solver for aeroacoustic problems;
4. Demonstrate and validate the improved resolution using the proposed high-order scheme for the problems of: a) propagation of a spinning acoustic mode in an axisymmetric aero engine inlet; b) flow past single cylinder at Reynolds number of 1.66×10^5 , and c) flow past tandem cylinder at Reynolds number of 1.66×10^5 .

NASA Applications

The developed high-order and low dissipation unstructured CFD technology for noise source prediction can also be directly applied to several of NASA's multidisciplinary noise and vibration programs such as the prediction of noise mechanisms and propagation for engine, fan, duct, propellers, and airframes, and for the analysis of wake/frame interaction induced noise and vibrations.

Non-NASA Applications

The present high-order low-dissipation CFD technology is also applicable to a wide range of applications that involve embedded flow features requiring high resolution with limited grid size. Such applications include turbomachinery, cavitation, biomedical, electronic cooling, and many others.

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NON-PROPRIETARY DATA